Assessment has long been integrated into the national culture of mathematics education, possibly more than in any other academic field. The main professional associations (AMS, MAA, SIAM) all maintain significant efforts to promote, discuss, and evaluate student standards, teaching methods and curriculum reform. Our department closely tracks the national dialog, incorporating specific changes and additions to our program as appropriate. More recently, we have made an effort to extend our assessment effort and make it more evident and transparent.

A. Undergraduate Assessment

Student learning outcomes. These include both the student mastery of the basic content required for success in fields where mathematics is applied, and — for our majors and minors — facility in more advanced notions like proof and derivation characteristic of an undergraduate mathematics degree. A list of student learning outcomes for the BA and BS degrees is to be found at the beginning of the first attached document, *Assessment Plan for the Mathematics Major*. Detailed learning outcomes are found in course syllabi, an example of which is the third attachment to this report.

Where found: [http://www.math.hawaii.edu/~dale/department_pr.html](http://www.math.hawaii.edu/~dale/department_pr.html) contains a pdf file under Assessment Plan. The detailed learning outcomes are chosen in accordance with tradition and national praxis, and published in the catalog description, in the official departmental syllabi and/or in the detailed syllabi distributed to students.

Curriculum. The curriculum is monitored continuously for its conformity to national standards, its suitability for the particular needs of our client departments, and its effectiveness with our students.

Who carries out the assessment? We have an established departmental assessment structure, including both a *curriculum committee* that meets almost monthly to review and revise the departmental curriculum, and a separate *assessment committee* which monitors the effectiveness of the program as a whole. The Associate Chair serves on both committees and
supplements their work with his own immediate and longitudinal analysis of student performance. Departmental engagement is encouraged by bringing all proposed changes to general department meetings for discussion and debate.

Departmental policy is to cycle teaching assignments so that all faculty regularly teach courses at all levels, from Math 100 through graduate offerings. As a result, all faculty have a current knowledge of what is taught in the introductory classes and what is retained by students as they enter upper-division courses, as well as an immediate stake in any proposals to change standards or procedure.

The UHM Foundations Board provides outside review for many of our courses; 11 of our courses are currently approved for general education ‘Foundations’ requirements, far more courses than any other department.

**How is assessment carried out?** Performance evaluation at the course level is by instruments such as examinations which emphasize problem solving.

Regular dialog with our client departments allows independent validation of the effectiveness of service offerings.

A capstone course and exit examination are now required of all our graduating majors; these were created to help us evaluate the extent to which our students have mastered our program’s skills and content. The examination (sample attached) covers both basic mathematical reasoning at the 200 and 300 level, and content from specific upper-division level courses. It is graded by the Assessment Committee, which then reports on the results both orally to the Department and in a written report circulated to all tenurable faculty. The capstone course is not only an instrument of evaluation, but also an opportunity to ensure that all of our majors have met the requirements set by the Manoa General Education Program. It typically includes library search, oral research presentation and a written research paper. At the conclusion of this course, the instructor reports to the faculty at a department meeting as to what he covered, where the student strengths and weaknesses were, etc.

Our majors are also invited to complete a post-graduation questionnaire to determine the extent to which their training with us was useful in their employment or further education.

A baseline is established through the use of placement exams for students entering our introductory sequence; approximately 800 students take these exams every year.

Most recently, we have started a longitudinal statistical analysis using data from Banner to evaluate transfer policies and track student performance throughout the Calculus sequence.

**Use of results.** The assessment activity has led to numerous reforms in recent years, including:
• Diversification of our Calculus offerings, including the introduction of new Calculus tracks specifically geared to Business students (Math 203) and Life Science students (Math 215–216).

• Substantial changes in the topic selection and order of presentation in the core Calculus sequences (Math 241–244 regular sequence, Math 251–253 accelerated and honors sequence). This has been accompanied by changes in the calculus text in consultation with client departments (particularly Engineering).

• A trial period with the so-called ‘Harvard Calculus’ reform program.

• Introduction of a new post-calculus service course for Engineers (Math 307).

• Conversion of Math 321 from an elective course in advanced calculus to a required transition course on methods of mathematical reasoning and proof, and introduction of a new course (Math 331) as a bridge to 400-level Analysis.

• Following recommendations of the Mathematical Association of America, a change in major requirements to require a linked 2-course sequence of upper-division courses.

• Working with the College of Education, a reintroduction of Math 111-112, Mathematics for elementary education, with a new approach.

**General Education Assessment within Mathematics.** As we have noted above, this has been a major factor in many of the changes we have implemented. We were only able to force all majors to take the capstone course and exit examination beginning with the past academic year, so it is not yet clear how well our changes have worked. We view assessment and reaction to it as an ongoing process of improvement, rather than something to be completed.

**B. Graduate Assessment**

**Student learning outcomes.** As for the undergraduate program, we look for both general and specific outcomes, and the specific ones are to be found in the syllabi for each course. The general ones for the MA degree include a broad knowledge of advanced mathematics, demonstrated by

- Good performance in the core graduate classes (Math 611–612, 631, 644).

- A total of 30 credit hours of math course work (some of which may be in a closely related field).

The other primary learning outcome is the demonstration of a deeper knowledge in a specific area of mathematics obtained through individual
research; this is demonstrated with both written and oral presentations under the direction of a Master’s Committee.

For the Ph.D. degree, the requirements are

- Show proficiency in two of French, German, Russian or a computer language.
- Demonstrate a broad and fairly deep knowledge of mathematics, particularly in algebra, real analysis, complex analysis and topology.
- Make a significant and original contribution to mathematics.

Where found:
http://www.math.hawaii.edu/~dale/GraduateRequirements.html

Curriculum. As for the undergraduate curriculum, the graduate curriculum is monitored continuously for its conformity to national standards, its suitability for the particular needs of our client departments, and its effectiveness with our students.

Assessment. Assessment of the students in the Graduate program is much more individualized than in the undergraduate program, and is traditionally far more intensive. It is done at several times in a student’s career, beginning when they first enter the Graduate program with an assessment test to determine the level at which they should be taking classes—we work with the student in deciding in which areas they need to develop more knowledge before beginning graduate classes. The Graduate Chair counsels each student on a regular basis regarding their progress in the program. In addition, students who hold a teaching assistantship are assessed by departmental teaching evaluations, routinely evaluated by the Graduate Chair and Associate Chair.

As detailed above, the M.A. program handles intermediate assessment through the coursework and does its exit assessment through a written thesis and oral presentation.

The assessment for the Ph.D. consists of several steps:

- Demonstration of language proficiency; this can be done either with professors in the Department or through language courses.
- Two Comprehensive Exams administered by committees formed by the Graduate Chair each semester, experts in the particular subject matter being tested.
- A third Comprehensive Exam administered by the student’s thesis committee. This exam may be written or oral and is in a specialized area determined by the committee. It determines readiness to begin thesis work.
- The Ph.D. thesis defense consisting of an oral presentation followed by questioning by the audience (which should at a minimum include
the Graduate Committee and the student’s thesis committee). The final decision is made by the thesis committee.

**Professional contributions.** Most of our Ph.D. students publish their work in international journals during the research process while still a student and/or after graduation. If they intend to continue in academic work, they will usually present a paper on their thesis work at a major meeting of the American Mathematical Society as part of their efforts to obtain a professorial position. Some students present papers earlier in their research program, but this is made difficult by our geographical isolation in Hawaii.

**Post-graduate activity.** We make an effort to track all of our graduate students throughout their careers. We see no problems with placement; a mathematics degree enables students to chose from a wide variety of technological fields. Some of our Ph.D. students have pursued distinguished careers in academia. Others have gone into industry, particularly in computer work or financial mathematics. A recent Hawaii-born Ph.D. graduate now works for the National Security Agency.

Many of our graduate degree holders are now on the faculty at the community colleges. Others are at Hawaii Pacific University and Chaminade University. The Community Colleges are currently experiencing difficulty recruiting mathematics faculty, and we remain the major source for them. Other graduate students who have stayed in Hawaii have gone into high tech industries or actuarial work.

**Assessment and program changes.** While there is always some minor tinkering going on with the requirements, the biggest changes have been the introduction of six more applied courses many years ago and a recent major change in the M.A. requirements. The M.A. change eliminated the requirement that students take a junior version of the comprehensive exams, substituting instead the written and oral presentation described above. The effect is to make the degree much more flexible so that a student now has much more power to tailor the program to fit his/her interests. In particular, they are no longer forced to follow a traditional pure mathematics track.

**Attachments**

- Assessment exam from Spring 2005
- Sample syllabus (Math 241), illustrating stated learning outcomes.